State of California Business, Transportation and Housing Agency

Memorandum

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To: Mr. Yen-Hsi Deng
Structures Design
MS#9-3/3G

Date: April 15, 2004

File: 11-SD-15
KP M35.4/M38.7
EA 11 – 080911

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 2, Branch D

Subject: Interstate 15, Managed Lanes Project, Unit 2: Foundation Recommendations for the Tieback Wall RW374L, Soil Nail Wall RW370L, and the Culvert Spanning for the Retaining Wall RW364L.

INTRODUCTION

In accordance with your request, a geotechnical investigation was performed for the purpose of providing foundation recommendations for the subject retaining structures that are required for construction of the I-15 Managed Lanes project. The investigation consisted of a site reconnaissance, a review of the existing as-built plans and geologic maps, limited geologic mapping, a subsurface investigation that included drilling and sampling, engineering analysis, and the writing of this report. Along with your request, the information provided included wall layout sheets on a scale of 1:1000 and pertinent cross sections which were reviewed and used for the purposes of this report.

GENERAL

The Culvert Spanning for the Retaining Wall RW364L.

A standard Type 1 retaining Wall RW364L is proposed for the widening of the existing offramp from southbound I-15 to Camino del Norte. From about Station 373.6 to 367+40, this wall, located at about the Right of Way boundary and 9.7 m in maximum height, will parallel the offramp to the west. Wall RW364L will retain a fill slope that is planned to be placed on the face of the existing fill embankment slope (ramp). At about Station 365+92, a major culvert about 2.7 m in diameter crosses the alignment of Wall RW364L. Foundation recommendations for a culvert spanning pile foundation for the Retaining Wall RW364L was requested from our office.

Soil Nail Wall RW370L

At the time of writing of this report, the exact profile and maximum height of the Soil nail Wall RW370L are not known by this office. However, it is our understanding that from approximate Station 368+39 to about Station 373+93, this wall will parallel I-15 along the western slope. Soil nail Wall RW370L is planned to retain a major cut in the existing east facing slope that bounds the freeway.

Tieback Wall RW374L

At the time of writing of this report the exact limits of the Tieback Wall RW374L, its profile and maximum height are not known by this office. However, it is our understanding that from about Station 374+73 to 377+96.3, this wall will roughly parallel I-15 and the Bernardo Center Drive southbound onramp. Tieback Wall RW374L is planned to retain a major cut in the existing east facing slope that bounds the freeway and the onramp.

GEOLOGY

The project site lies within the western San Diego Peninsular Ranges Geomorphic Province of California. The project area is generally underlain by fill materials, topsoil, and/or colluvium, and locally alluvium. These surficial geologic units are underlain by the sedimentary upper Tertiary Mission Valley Formation that is underlain by the Stadium Conglomerate Formation that in turn is underlain by lower Tertiary Friars Formation.

The Friars Formation is underlain by a Mesozoic basement consisting of igneous and metamorphic rocks. The basement, which upper layer is weathered, is composed of upper Jurassic Santiago Peak Volcanics and mid Cretaceous granitic rocks of the Southern California Batholith (Kennedy and Peterson, 1975).

The Mission Valley Formation is composed of marine, lagoonal, and nonmarine sandstone that lies conformably upon the Stadium Conglomerate. It consists of friable and soft sandstone that locally is interstratified with carbonate cemented beds (concretions). Locally it comprises cobble conglomerate zones. Locally it grades to silty sand/sandstone. Shallow and localized slipouts are known to occur in the hilly topography where the Mission Valley Formation soils were exposed on slopes.

The Stadium Conglomerate consists of cobble conglomerate with a coarse-grained sandstone matrix. The sandstone can constitute up to 50 percent of the unit. However, the cobbles, up to 0.5 m in diameter, are the most dominant ingredient of the unit. Stadium Conglomerate Formation is resistant to erosion and known not to be susceptible to sliding or slipouts.
The Friars Formation consists of siltstone and sandstone with interbeds of claystone. Landslides are common in the clay-rich part of the formation that is exposed on slopes in the hilly topography. Please refer to the section titled: "Project site geologic background and history" for more pertinent information.

Colluvium consists of formational materials, including topsoil that were eroded and deposited as a relatively thin mantle on the faces of slopes. Alluvium consists primarily of stream deposits of silt (often clayey), sand, and gravel derived from bedrock and residual sources that lie within or near the project area. Fill consists of compacted earth materials derived from local sources.

PROJECT SITE GEOLOGIC BACKGROUND AND HISTORY

The project site is located in the community of Rancho Bernardo, in the City of San Diego, along the segment of I-15, between the Camino Del Norte and Rancho Bernardo Road Undercrossings. That stretch of the freeway, in general, is underlain by fill materials, native soils of the Mission Valley Formation, Stadium Conglomerate, and Friars Formation. Therefore, based on our local experience and review of geologic literature, the project area is underlain in large part by geotechnically adverse sedimentary formations, mainly the Friars and Mission Valley Formations (Hart, 1972; Kennedy and Peterson, 1975). In the past, numerous landslides occurred in proximity to and along the segment of I-15 where the planned walls are to be located. Several reports on file in our Office of Geotechnical Design describe a large number of slope instability (landslide) problems in the project area (Allen, 1979; Mattox, 1983; Egan 1983 and 1992; Tesar 2002). In the report titled "Seismic safety study for the City of San Diego", issued in 1974, the Leighton and Associates consultants designated the southwestern quadrant of the Bernardo Center Drive (the location of Wall RW374L) as: "confirmed, known, or highly suspected landslide" (Leighton and Associates, 1974). In addition, on the State of California Landslides Map the majority of the project area is classified as 'Most Susceptible to Landslides' (California Division of Mines and Geology, OFR 95-04, Plate 35F). In 1998 the grading of a building pad that is adjacent to our Right of Way and located in the northwestern quadrant of Bernardo Center Drive triggered ongoing slope instability that will require extensive and complex mitigation measures (Birkhahn, 2002). In 1998 a Preliminary Geotechnical Report, titled "PGR Busway/HOV/Managed Lanes on I-15 from Sate Route 163 (SR-163) to SR 78" was issued to Mr. Robert Robinson (Oquita, 1998). In this report, the notorious claystone of the Friars Formation was singled out as potentially contributing to present and future stability problems where it underlies the traveled way. A 2000 report titled: "Preliminary Recommendations on Retaining Walls" was issued to Mr. Bruce Lambert from the Office of Advanced Planning (Yazdani and Hinman, 2000). In this report, among other geotechnical concerns related to the notorious instability of the project area, the cut slope in the southwestern quadrant of Bernardo Center Drive (location of Wall RW374L) was identified as only marginally stable. The authors stated that the temporary cut necessary to construct a Type 1 retaining wall, if needed, would most likely trigger the existing landslide and possibly jeopardize structures located at the top of the slope. Therefore, a tieback wall was recommended for that location.
In the light of the geologic facts and the historical background of the project site it is obvious, that the majority of the project area is underlain by soils inherently prone to slope instability, including landslides.

SEISMICITY

No known Holocene faults exists within the project area. The nearest known active fault is the Newport-Inglewood-Rose Canyon Fault Zone believed to be capable of producing an earthquake with a Maximum Credible Magnitude of 7.0 on the Richter scale. It is located about 20 km southwest and west from the project site. The La Nacion Fault is located about 20 kilometers south from the project limits, and it is capable of producing an earthquake with a Maximum Credible Magnitude of 6.75 on the Richter scale. In addition, the Elsinore Fault lies about 40 km northeast from the project limits; it is capable of producing an earthquake with a Maximum Credible Magnitude of 7.5 on the Richter scale. All three aforementioned faults are believed to be capable of generating a Peak Ground Acceleration of about 0.25 g at the project site (Mualchin, 1996).

GROUNDWATER

Culvert Spanning for the Retaining Wall RW364L

Groundwater was encountered in several of the exploratory borings drilled at about the location of the alignment of the Wall RW364L, including the culvert spanning location. Groundwater could potentially impact the construction of the drilled pile foundation. The installation of temporary de-watering wells or pile casing may be required to facilitate pile construction. Groundwater will have no impact on the construction of the pile cap or spread-footing foundations for Wall RW364L. Table 1 below provides a summary of groundwater data for retaining Wall RW364L.

Table 1. Summary of Groundwater Data for Wall RW364L

Boring No.	Date Drilled or Groundwater measured	Boring Maximum Depth Elevation (m)	Groundwater Elevation (m)
RW364L-B1	1/5/04	202.15	Not Encountered
RW364L-B2	1/8/04	196.80	202.90*
RW364L-B3	1/8/04	202.81	204.96
RW364L-B4	1/8/04	204.81	205.13

Note: * - Seepage

Soil Nail Wall RW370L

Groundwater was not encountered in any of the exploratory borings drilled near the alignment of Soil nail Wall RW370L nor was any seepage observed. However, groundwater condition, mainly seepage water, may occur at isolated locations during the construction phase of the wall. In general, the occurrence of ground water is not likely to have a significant impact on wall

construction. In the event that unanticipated groundwater is encountered during construction, groundwater mitigation recommendations will be provided by this office. In addition, standard groundwater mitigation measure proposed for the Soil nail Wall RW370L should sufficiently drain/mitigate any groundwater when the wall is built. Table 2 below provides a summary of groundwater data for the Soil nail Wall RW370L.

Table 2. Summary of Groundwater Data for Soil Nail Wall RW370L

Boring No.	Date Drilled or Groundwater measured	Boring Maximum Depth Elevation (m)	Groundwater Elevation (m)
RW370L-B1	1/5/04	226.6	Not Encountered
RW370L-B2	1/23/04	227.4	Not Encountered
RW370L-B3	1/5/04	219.5	Not Encountered
RW370L-B4	1/6/04	221.0	Not Encountered
RW370L-B5	1/22/04	219.8	Not Encountered
RW370L-B6	1/7/04	217.4	Not Encountered

Tieback Wall RW374L

Groundwater was encountered in several of the exploratory borings drilled at about the location of the alignment of the Tieback Wall RW374L, mostly as intense seepage in bucket auger borings. The intensity of seepage, could increase significantly in response to the intensity of precipitation or irrigation discharge water from the residential area located at about the crest of the slope to be retained. Groundwater could potentially impact the construction and performance of the wall. In order to mitigate the adverse groundwater condition, we recommend that horizontal drains be located at the base of the wall. Drains should consist of 100 mm in diameter slotted PVC drains, spaced at minimum 6.0 m interval, extending at least 6 0 m west from the Tieback Wall RW374L alignment (into the cut slope) and inclined 5 degree above horizontal. Horizontal drains should extend through the wall structure and terminate about 150 mm above the final ground surface. Table 3 on the following page provides a summary of groundwater data for the Tieback Wall RW374L.

Table 3. Summary of Groundwater Data for Tieback Wall RW374L

Boring No.	Date Drilled or Groundwater measured	Boring Maximum Depth Elevation (m)	Groundwater Elevation (m)
RW374L-B1	1/7/04	215.18	Not Encountered
RW374L-B2	1/28/04	199.73	204.85
RW374L-B3A	1/29/04	202.45	209.16
RW374L-B4A	1/14/04	189.96	193.60
RW374L-B6	1/27/04	195.71	195.71
RW374L-B6A	2/2/04	188.35	193.23
RW374L-B7	1/20/04	189.16	192.21

CORROSION

Retaining Wall RW364L (Culvert Spanning)

Several soil samples were collected from the location of retaining Wall RW 364L including the location of the culvert spanning proposed for this project. These samples were tested for corrosive potential and found to be corrosive. The results of the corrosivity tests are presented in Table 4 below.

Table 4. Results of Corrosivity Tests for Retaining Wall RW364L.

BORING NO.	SAMPLE DEPTH (m)	pH	MINIMUM RESISTIVITY (ohm-cm)	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RW364L-B1	2-5	7.8	1010	500	N/A
RW364L-B2	5-10	7.4	520	150	N/A
RW364L-B3	5-10	7.0	450	100	N/A

Note: Caltrans defines a corrosive area as an area where the soil and/or water contains more than 500 ppm of chlorides, more than 2000 ppm sulfates, has a minimum resistivity of less than 1000 ohm-cm, or a pH of 5.5 or less.

Soil Nail Wall 370L

Several soil samples were collected from the location of Soil nail Wall RW370L proposed for this project. These samples were tested for corrosive potential and found to be corrosive. The results of the corrosivity tests are presented in Table 5 on the following page.

Table 5. Results of Corrosivity Tests for Soil Nail Wall RW370L.

BORING NO.	SAMPLE DEPTH (m)	pH	MINIMUM RESISTIVITY (ohm-cm)	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RW370L-B1	2-5	7.4	880	190	N/A
RW370L-B4	2-5	7.7	630	300	N/A
RW370L-B6	2-5	7.6	1010	220	N/A

Note: Caltrans defines a corrosive area as an area where the soil and/or water contains more than 500 ppm of chlorides, more than 2000 ppm sulfates, has a minimum resistivity of less than 1000 ohm-cm, or a pH of 5.5 or less.

Tieback Wall 374L

One soil sample was collected from the location of the Tieback Wall RW374L that is proposed for this project. This sample was tested for corrosive potential and found to be corrosive. In addition, soils that underlain the alignment of planned Wall RW374L are of Friars Formation origin and as such are inherently corrosive. The results of the corrosivity tests are presented in Table 6 below.

Table 6. Results of Corrosivity Tests for Retaining Wall RW374L.

BORING NO.	SAMPLE DEPTH (m)	pH	MINIMUM RESISTIVITY (ohm-cm)	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RW374L-B1	2-5	7.4	680	350	N/A

Note: Caltrans defines a corrosive area as an area where the soil and/or water contains more than 500 ppm of chlorides, more than 2000 ppm sulfates, has a minimum resistivity of less than 1000 ohm-cm, or a pH of 5.5 or less.

FOUNDATION RECOMMENDATIONS

Retaining Wall RW364L

Subsurface Soils Conditions

From approximate Station 365+30 to 366+60, the alignment of Wall RW364L is underlain by fill materials predominately derived from the local cuts in the Mission Valley Formation. From approximate Station 365+30 to the southern limit of the wall, and from approximate Station 366+60 to its northern limit, the wall alignment is underlain by clayey and silty soils of the Mission Valley Formation.

Foundation Recommendations

Based on the results of our subsurface investigations and engineering analyses, the design and construction of this wall may be based on the Caltrans Standard Plans for Type 1 wall. We recommend that this wall, 9.7 m in maximum height, be supported on a spread footing foundation as shown on sheet B3-2 in the "Standard Plans July 1999". With Loading Case II, the 370 kPa Gross Allowable Soil Bearing Pressure may be used for design of the wall. In addition, we recommend that from Station 365+60 to 367+40, a 1.5 m thick layer of fill materials be removed from under the bottom of the proposed footing and replaced with structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216. The horizontal limits of the removal and replacement should extend a minimum 1.5 m beyond either edge of the proposed wall footing.

Construction Considerations

Based on the results of our subsurface investigation, our local experience, and the review of geologic references, we anticipate that excavations for wall foundations may be accomplished with the use of standard (heavy) earthwork equipment.

Culvert Spanning for the Retaining Wall RW364L

Subsurface Soils Conditions

The following recommendations are for the proposed Culvert Spanning for Wall RW364L, as shown on the preliminary plans provided by the Office of Structures Design on March 30, 2004. In the past, a gully and drainage course (minor stream flowing southwest) crossed the project area. During the grading of the freeway a culvert, about 2.7 m in diameter, was constructed at about Station 365+90, and the gully was backfilled. Therefore, the alignment of the proposed Culvert Crossing for the Retaining Wall RW364L is underlain by fill materials predominately derived from local cuts in the Mission Valley Formation. The fill consists of clayey and sandy soils. Based on our local experience, we believe that such type of fill materials can contain a significant amount of buried oversized rocks or/and man-made objects.

Foundation Recommendations

In view of the potential presence of cemented concretions, boulders and cobbles, and man-made objects in the existing fill that underlies the project site, we do not believe that driven piles are feasible at this specific project location. Accordingly, we recommend that 610 mm Cast-In Drilled-Hole (CIDH) piles be utilized to support the referenced culvert crossing. The specified pile tip elevation is listed below in Table 1. The ultimate geotechnical pile capacity for the CIDH piles will meet or exceed the design loading listed in the Table 7 on the following page.

Table 7. Pile Data: 610 mm CIDH Concrete Pile

Location	Pile Type	Nominal Compression (kN)	Design Load (kN)	Lateral Load (kN)	Design Tip Elevation (m)	Specified Tip Elevation (m)
Culvert Spanning for Wall RW364L	610 mm CIDH	1086	543	200	198.5 (1) (2)	198.5.0

Note: Design tip elevation is controlled by the following demands: (1) Nominal Compression, (2) Lateral Load. Load information provided by Office of Structure Design on March 17, 2004.

Construction Considerations

1. The calculated geotechnical capacity of the CIDH pile is based entirely upon skin friction to be obtained from the Mission Valley Formation. However, the bottom of the drilled hole should be cleaned of sediment and debris prior to placement of the reinforcing cage and concrete.

2. Caving conditions may be encountered during CIDH pile construction. Temporary casing may be necessary to control caving during construction. All temporary casing should be removed during concrete placement.

3. Groundwater was encountered during our subsurface investigations (drilling), and it is anticipated that groundwater will be encountered during CIDH pile installation. Temporary de-watering wells or shaft casing are techniques that may be necessary to control groundwater.

4. De-watering of drilled pile excavations is anticipated to be feasible where groundwater is encountered. The contractor is to be required to keep drilled excavation dry, where groundwater is encountered by pumping methods, immediately after the boring has reached specified tip elevation until the time concrete is placed for construction of the pile.

5. Difficult drilling conditions are anticipated due to the possible presence of hard zones of concretions, boulders and cobbles within the fill material, as described in the geology section of this report.

Soil Nail Wall RW370L

Subsurface Soil Conditions

Along the southbound I-15 interval, from Station 368+39 to Station 373+93, a Soil nail Wall RW370L is proposed to retain a planned cut in the existing east facing cut slope. The maximum

height of the wall will be about 10.0 m. Native soils along the alignment of the proposed Soil nail Wall RW370L belong to the Mission Valley Formation and comprise silty and clayey sands, sands with some gravel (gravelly zones). Locally, indurated zones (layers and lenses) were encountered during the subsurface investigation of 2004. In addition, layers and/or lenses of relatively low-density sands were encountered. Geotechnical soils parameters presented in Table 8 below were established based on the laboratory tests, field index tests, and our local experience.

Table 8. Geotechnical Soil Parameters for Soil Nail Wall RW370L

Geotechnical Unit	Cohesion (kPa)	Angle of Internal Friction (degree)	Maximum Dry Density ($kN/m^{3)}$
Mission Valley	21	33	19.6

Note: Bond Stress = 90 kPa

Global Slope Stability

Based on limited cross – sections provided by the Project Engineer, slope stability analyses were performed. In general, satisfactory factors of safety were obtained for the proposed slopes that are located above the planned Soil nail Wall RW370L. Global and internal stability analyses were performed for the wall heights ranging from less than 2 m to 10 m.

General Geotechnical Design Parameters

Table 9 on the following page presents the general geotechnical design parameters for the Soil nail Wall RW370L.

Table 9. General Geotechnical Design Parameters for Soil Nail Wall RW370L

Maximum Wall Height (m)	Number of Nail Layers	Nail Embedded Length (m)	Vertical Distance to First Layer (m)
10	7	9	0.5
9	6	9	0.75
8	5	6	1.0
7	5	6	0.5
6	4	6	0.75
5	3	3	1.0
4	2	3	0.5
3	2	3	0.75
2	2	3	0.25
<2	1	3	0.5

Notes: The following design assumptions were used in the wall analyses and should be incorporated into the wall design.

- The location of the first (top) layer of nails may be modified in some sections of the wall to adjust for the drainage ditch (brow ditch) above the wall; those sections are not defined at this time.
- Nails are to be laid in checkered pattern when there are two or more layers of nails.
- All nails are inclined at 15 degrees
- Vertical spacing of nail layers (S_v) is 1.5 m
- Horizontal spacing of nail layers (S_h) is 1.5 m.
- Design Punching Shear (PS) for the nail head is 263 kN.
- Design Yield Stress (FY) for nail is 379 MPa.
- Ultimate Bond Stress is 90 kPa.
- Minimum drilled hole diameter is 152 mm.
- All nails have a minimum diameter of 32.0 mm.
- All nails are full length encapsulated.
- Nails are to start no more than 0.75 m of the horizontal distance from the wall ends.
- Geocomposite drains with plastic face on concrete and filter fabric face on soil side should be at least 0.6 m wide and placed at 1.5 m spacing, center to center. The bottom ends of the geocomposite drains should be secured into the 610 mm long slots saw cut into the top of the 100 mm in diameter PVC drainage pipe.
- Testing of nails should conform to the Caltrans Soil-nail Wall specifications.
- All nails one length for a specified wall height

Construction considerations

Due to the presence of layers or/and lenses of concretions and gravelly/cobbly zones we anticipate hard drilling conditions in localized areas along the wall alignment. A combination of standard augering and percussive air drilling equipment may be required for shaft excavation. In addition, we anticipate that caving conditions in loose sandy lenses and layers could be encountered during the drilling for the soil nails. Caving should not inhibit shaft excavation but may result in a moderate increase of grout quantity. Also, groundwater, most likely seepage, could adversely affect the construction of the wall

Tieback Wall RW374L

Subsurface Soil Conditions

Along the southbound I-15 interval, from Station 374+73 to 377+96, the tieback Wall RW374L is proposed to retain a planned cut in the existing east facing cut slope. The maximum height of the wall is not known at the time of writing of this report. The alignment of the proposed Wall RW374L is underlain by a relatively thin (1.2 m in maximum thickness) mantle of colluvium and/or fill that is underlain by the Stadium Conglomerate Formation that in turn is underlain by the Friars Formation. The sharp contact between the Stadium Conglomerate and Friars Formations was mapped to traverse the existing slope at about an elevation of 209. 00 m. Accordingly, at the face of the proposed cut for Wall RW374L, from about Station 375+35 to 376+85, the (upper) Stadium Conglomerate and (lower) Friars Formation contact is expected to traverse the cut, along the contour line of about 209.00 m.

The Stadium Conglomerate comprises a conglomerate consisting of gravel, cobbles, and boulders within moderately cemented sandy matrix. Locally, concretion zones were encountered within this geologic unit.

Based on the degree of weathering, frequency of the occurrence of the adverse discontinuities, and overall condition of the soils of the Friars Formation we have subjectively divided them into two geologic units: Upper and Lower Friars Formations.

The Upper Friars consists of claystone, siltstone, and sandy siltstone, often heavily fractured and friable, with numerous discontinuities that could be classified as slip planes and/or planes of weakness, along which movement (slide) has occurred or could potentially occur. In addition, several slide planes were mapped within this geologic unit.

The Lower Friars Formation consists of siltstone and sandstone with significantly fewer adverse discontinuities present.

In addition, landslide mass/debris zones consisting of clayey soils often with sandy nodules/blobs were mapped in Borings: RW374L-B7A, RW374L-B7, RW374L- B6A, and RW374L-B4A.

Design Parameters

For the design parameters of the Tieback Wall RW374L see Attachment 1: TABLE 10. Wall RW374L: Tieback Wall Design Parameters 04/15/04.

Design and Construction Considerations

The height of Wall 374L shall be a minimum of three meters, and a minimum of two rows of anchors shall be used except at wall ends. One row of anchors may be used only within 15 meters of wall ends. A portion of the wall may be buried below final grade. The angle of wall batter may vary by plus or minus five degrees. Wall design parameters are contained in Table 10.

In general, tie-back shafts may be excavated with standard augering equipment. However, the following adverse conditions will be encountered:

1) Shafts drilled above an elevation of about 209.00 meters will encounter Stadium Conglomerate Formation that contains cobbles up to 0.3 meters in diameter. The conglomerate exists along the southern 180 meters of Wall 374L. Percussive air drilling or other specialty equipment may be required for shaft excavation within the conglomerate.

2) Perched groundwater will be encountered sporadically during shaft excavation. The elevations where groundwater seepage was encountered during the subsurface excavation is given in Tables 7 and 10. The contractor should anticipate shaft excavation and grouting under "wet" conditions.

3) Mild to moderate caving conditions may be encountered during shaft excavation. Potential caving conditions are most likely to be present along the northern 160 meters of Wall 374L above an elevation of 190 meters where landslide soils are present. Mild sloughing may occur and occasional casing of shafts to a depth of 10 meters may be required.

For excavation of the wall face, a maximum lift height of 2.15 meters shall be allowed. To the greatest extent possible, soil excavated from each lift shall be stockpiled along the outer edge of the lift bench so as to remain as landslide resisting force until the tie-backs have been tensioned.

The standard special provisions for tie-back tensioning and testing provided by Caltrans Office of Structural Design are suitable for this project.

All Logs of Test Borings for the subject retaining structures were developed and submitted to the Project Engineer, Mr. Tan Doan.

If you have any question regarding this report, please call Jeff Tesar at (858) 467-2716 (Calnet 734-2716) or Brian Hinman at (858) 467-4051 (Calnet 734-4051).

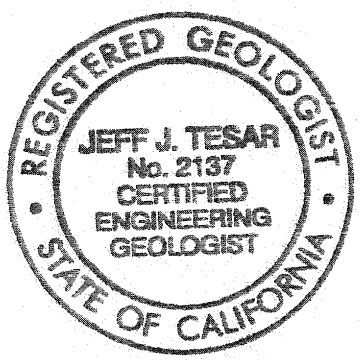
Prepared by:

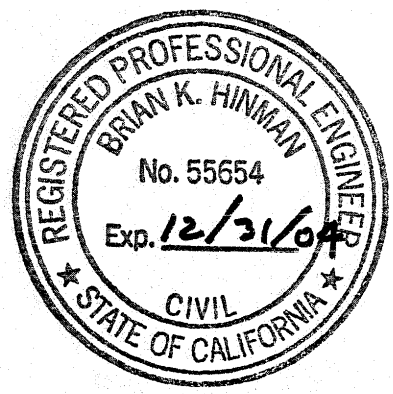
J. Tesar.

Jeff Tesar,
Engineering Geologist,
Office of Geotechnical Design-South 2
Branch D

Brian Hinman

Brian Hinman
Senior Transportation Engineer
Office of Geotechnical Design – South 2
Branch D





Attachments:

TABLE 10. Wall 374L: Tieback Wall Design Parameters 04/15/04

References:

1. Michael W. Hart, Landslides of West-Central San Diego County, 1972.

2. Michael P. Kennedy and Gary L. Peterson, Geology of the San Diego Metropolitan Area, California, Poway Quadrangle, California Division of Mines and Geology, Bulletin 200, 1975.

3. State of California Landslide Map, Landslide Hazard Identification Map No. 35, California

Division of Mines and Geology, OFR 95-04, Plate 35F, 1995.

4. R. D. Allen, Landslide Repair at Carmel Mountain Road Overcrossing, 1978.

5. Joe Egan, The Bernardo Center Drive Landslide, 1983 and 1992.

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8. Zia Yazdani and Brian Hinman, Preliminary Recommendations on Retaining Walls, 2000.

9. Jeff Tesar, Interstate 15 and Bernardo Center Drive Transit Center: Geologic Investigation, 2002.

10. Phillip Birkhahn, Repair Proposal for the Point and Caltrans Right of Way, 2002.

11. Woodward and Associates and Leighton and Associates, Seismic Safety Study for the City of San Diego, 1974.

12. L. Mualchin, California Seismic Hazard Map, 1996

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TABLE 10
11-080911: I-15 Managed Lanes Project Unit 2
Wall 374L : Tie-Back Wall Design Parameters 04/15/04

Begin Sta.	End Sta.	Wall Batter	Anchor Batter (degree)	Unbonded Length	Anchor Force (kN)			Groundwater Elev.	Soil Stratigraphy				
						Horz. Spacing (m)			Type	Bottom Elev.	γ (kN/m^3)	c (kPa)	σ
374+73	376+80	65°	25 40	37 m 25 m	**No. of Rows**	3	2	209 m	Stadium Conglomerate	209 m	22.8	14.2	35°
					3	550	367		Upper Friars Fm.	198 m	19.6	14.2	26°
					2	825	550		Lower Friars Fm.		19.6	14.2	31°
					1	250	167						
376+80	377+96	65°	25 40	29 m 20 m	**No. of Rows**	3	2	196 m	Landslide Debris	195 m	19.6	0	22°
					3	550	367		Sheared Friars Fm.	183 m	19.6	0	26°
					2	825	550		Lower Friars Fm.		19.6	14.2	31°
					1	250	167						

1) Sheared Friars Formation contains fissured clay seams with no cohesion and $\sigma = 7^o$ to 9^o
2) The wall batter is measured from horizontal. The wall batter may vary by plus or minus 5 degrees.
3) Perched groundwater elevations are based on average elevations of seepage encountered in soil borings.
4) One row of anchors may be used only wthin 15 meters of wall ends.
5) The wall height shall be a minimum of three meters and a minimum of two rows of anchors shall be used except at wall ends.
6) A portion of the wall may be buried below final grade.